d.) Remarks

Response to Office communication

This communication is responsive to the Office communication of October 8, 2003. Claims 1-55 are currently pending, claims 1-18, 20, 22, and 24 having been amended and claims 25-55 having been added by this amendment. Support for the new claims and amendments can be found throughout the specification as originally filed.

The present invention is directed to an electrolyte system for an energy storage device, especially for use in applications where safety is critical, for example, in medical devices that are implanted in a patient's body. Prior art batteries commonly contain flame retardant solvents in the electrolyte solution to reduce flammability. Unfortunately, these solvents do not have the properties desired for an electrolyte, such as high conductivity. The Applicants herein have identified a significant breakthrough in the use of flame retardants in conjunction with a battery electrolyte. In particular, the Applicants realized that, by choosing a flame retardant that is substantially immiscible with the nonaqueous electrolyte solution, the flame retardant would blanket the electrolyte solution instead of dissolving in it, reducing flammability without degrading its electrolytic properties.

Specification

The language objected to as introducing new matter on page 15 of the specification has been canceled without prejudice, and language has been added that is clearly supported by claim 18 as originally filed. Also, a grammatical error has been corrected at page 18, line 19, and Table 1 has been amended to show that the units for the additive are in weight%.

Claim Rejections – 35 USC § 112

Claims 14, 15, and 17 were rejected, stating

> "while being enabling for perfluoro-1,3-dimethylcylcohexane and $C_{15}F_{33}N$ as the halogen compound that is a flame retardant material ... the specification does not enable any person skilled in the art to which it pertains, or with which it is most nearly connected, to make the invention commensurate in scope with these claims. The specification provides only the above 2 examples of halogen containing compounds that are flame

retardant materials that are liquid at room temperature and pressure, and substantially immiscible in the nonaqueous electrolyte solution."

It is submitted that the two examples provided in the present application, Example 1 and Example 2, represent the genus of claims 1 and 20, the subgenus of claim 4 and new claim 43, and the species of claim 14 and new claim 44, and that Example 2 represents the species of claim 15 and new claim 47, and that, of the following groups: branched or unbranched alkyl, cyclic alkyl, ether, aminoalkyl, and aliphatic heterocyclic compound groups in which one or more hydrogen atoms are substituted by a halogen, perfluoroalkyl groups, perfluoroaminoalkyl groups, and perfluoroether groups, only three are not exactly represented by Examples 1 and 2. Furthermore, flame retardants representing the three unrepresented members, namely, branched alkyl, ether, and perfluoroether, can be found in the three cited references, Arai, Narang et al., and JP 10-012272 A. For example, Galden HT90 mentioned in Narang et al. is an ether and a perfluoroether. HFE7100, $C_4F_9OCH_3$, mentioned in Arai consists of two inseparable isomers, including one branched alkyl and one unbranched alkyl fluoroether, thereby representing the branched alkyl and ether groups. JP 10-12272 also lists $C_4F_9OCH_3$ in claim 3, and mentions branched groups in paragraph [0026].

It is submitted that the present specification is sufficient to enable a person skilled in the art to make and use the claimed invention. It is submitted that one of ordinary skill in the art would know that, to make the claimed invention, one may obtain a chemical known to be flame retardant and liquid at room temperature and pressure, and attempt to mix it with a nonaqueous electrolyte solution to determine whether the flame retardant is substantially immiscible in the nonaqueous electrolyte solution. According to page 11, lines 14-16, "Substantially immiscible means that when the non-aqueous electrolyte solution and the halogen-containing compound are mixed, a meniscus between the two liquids is formed..." (Of course, the flame retardant is not limited to halogen-containing compounds, and immiscibility would be determined in the same way for non-halogen-containing flame retardants.) This test is simple and straightforward, producing easily determinable results; all one need do is look for a meniscus formed between the flame retardant and the nonaqueous electrolyte solution. In fact, even without obtaining and testing the flame retardant with the nonaqueous electrolyte solution to check for a

meniscus, miscibility is at least somewhat predictable as shown in cited reference U.S. Patent 6,210,835 to Arai, issued April 3, 2001, in which miscibility of the flame retardant with solvent of the non-aqueous electrolyte solution is indicated as desirable. Per column 9, lines 38-52,

> "As is obvious from Table 2, solvents having a higher dipole moment than 3 debyes of Comparative Examples 2 to 5, i.e. PC, EC, GBL and BC are not compatible with the non-flammable solvent HFE7100. It seems therefrom that the compatibility largely depends on differences in the solvent polarity....It can be seen from the forgoing that the solvent to be mixed with the non-flammable fluorinated solvent preferably have a dipole moment of not more than 3 debyes."

Therefore, it is submitted that the electrolyte system of claim 1 and the energy storage device of claim 20 may be made and used with little or no experimentation, and that the claims are clearly enabled. The last Office communication stated,

> "There are more than thousands, if not millions of compounds that are halogen containing compounds that contain branched or unbranched alkyl, cyclic alkyl, ether, aminoalkyl, perfluoroalkyl groups, perfluoroaminoalkyl groups, perfluoroether groups, or aliphatic heterocyclic compound groups in which one or more hydrogen atoms are substituted by a halogen selected from the group consisting of fluorine, chlorine, and bromine. One has to determine from these innumerable halogen containing compounds which are flame retardant materials followed by determining which of these innumerable possibilities are liquid at room temperature and would be immiscible with a numerous variety of nonaqueous solvents."

However, it is submitted that 35 USC 112 requires that

> "The specification shall contain a written description of the invention, and of the manner and process of making and using it, in such full, clear, concise, and exact terms as to enable any person skilled in the art to which it pertains, or with which it is most nearly connected, to make and use the same..."

It is respectfully submitted that, to make and use the invention, there is no requirement to determine all of the possibilities that are encompassed by the claims. The possibilities encompassed by claims 14 and 15 and 44 and 47 are subsets of those of claims 1 and 20, and for the same reasons that the enablement requirement does not require one to determine all of the possibilities that are encompassed by independent claims 1 and 20, it also does not require one to determine all of the possibilities that are

encompassed by dependent claims 44 and 47. It is further submitted that undue experimentation is not required for one of ordinary skill in the art to make and use the claimed invention. Therefore, it is submitted that claims 14 and 15 and new claims 44 and 47 are enabled. Applicants respectfully request reconsideration of this rejection.

Amended claim 18 was rejected under 35 U.S.C. 112, first paragraph, as failing to comply with the written description requirement. Claim 18 has been amended and is clearly supported by claim 18 as originally filed.

Claim Rejections – 35 USC § 102

The rejection on Narang et al. (US 5,830,600)

Claims 1-9, 11-15, 20, 21, and 23 were rejected as being anticipated by Narang et al. (US 5,830,600) and as evidenced by Galden PFPE:Heat Transfer Fluids Product Data Sheet for Galden ® HT90 Fluid pp. 1-3 and Data sheet for Ethylene Carbonate obtained from Chemfinder.com.

The Office communication states,

> "Narang et al. disclose a battery comprising a lithium metal anode, a $LiMn_2O_4$ cathode and a fire-retardant electrolyte composition comprising perfluoropolyether Galden ® HT90 (Formula weight=460) and ethylene carbonate (col. 22, lines 25-35) in a 1:1 volume ratio and lithium bis(trifluoromethane-sulfonate) imide as the electrolyte salt (col. 20, lines 50-60)."

It is respectfully submitted that ethylene carbonate is a solid at room temperature. Therefore, if it is miscible with the perfluoropolyether Galden ® HT90 flame retardant, the reference does not teach applicant's invention, and if it is not miscible, the electrolyte solution would not be a liquid, as independent claim 1 is now limited. Furthermore, there is no teaching in Narang et al. for how to use a solid electrolyte to make an energy storage device.

The rejection on JP 10-012272A (JPO Machine Translation)

Claims 1-9, 11-15, 20, 21, and 23 were rejected as being anticipated by JP 10-012272A (JPO Machine Translation). It is submitted that this reference does not teach or suggest an energy storage device comprising a nonaqueous electrolyte solution and a flame retardant material that are substantially immiscible, that is, when mixed, form

a meniscus between them (page 11, lines 14-16). Furthermore, the reference does not teach an energy storage device wherein a nonaqueous electrolyte solution occupies a region defined by a separator, and a flame retardant material is not in the region defined by the separator.

Paragraph [0006] of the JPO Machine Translation teaches that the electrolytic solution contains the fluorine ether flame retardant material, and paragraph [0023] teaches, "mixing the fluorine organic solvent ... in the electrolytic solution" (emphasis added); therefore, the flame retardant solvent cannot be substantially immiscible in the nonaqueous electrolyte solution because it would not be in the solution if it were substantially immiscible; furthermore, if the nonaqueous electrolyte solution occupies a region defined by the separator, the flame retardant material would also be in that region, since the electrolytic solution contains the flame retardant material.

The rejection on Arai (US 6,210,835 B1)

Claims 1-9, 11-15, and 20-23 were rejected as being anticipated by Arai (US 6,210,835 B1). It is submitted that this reference does not teach or suggest an energy storage device comprising a nonaqueous electrolyte solution and a flame retardant material that are substantially immiscible, that is, when mixed, form a meniscus between them (page 11, lines 14-16). It is further submitted that Arai does not teach an electrochemical storage device wherein the nonaqueous electrolyte solution occupies a region defined by the separator, and the flame retardant material is not in the region defined by the separator.

Claim Rejections – 35 USC § 103

Claims 17-19 were rejected as being unpatentable over the cited references. However, it is submitted that in the present invention, new and desirable results are obtained by selecting the order of the steps according to claims 17-19 and new claims 54 and 55. In the present invention, the flame retardant material does not mix with the electrolyte, so the properties of the electrolyte are not degraded by the flame retardant. There is no intention in the present invention of mixing the electrolyte with the flame retardant to form a solution. By filling the casing at least partially with the nonaqueous electrolyte solution, waiting a period of time sufficient for the nonaqueous electrolyte solution to penetrate one or more pores of the electrode assembly, and then adding the flame retardant material, penetration of the electrolyte solution into the electrode assembly can be maximized, with the flame retardant material blanketing the electrolyte-soaked electrode assembly. (See p. 5, line 7 – p. 6, line 8.) On the other hand, Narang et al. teach fire-retardant electrolyte compositions comprising a lithium salt dissolved in a fire-retardant solvent (see abstract). It would be nonobvious to try to add the flame retardant solvent of Narang et al. after adding other electrolyte components to the battery case because it would be difficult to adequately mix the components to form the solution of Narang et al. Furthermore, in contradistinction to the present invention, there is no teaching or motivation in any of the cited references to add flame retardant after adding a nonaqueous electrolyte solution.

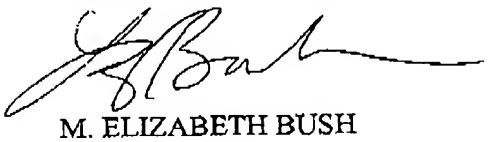
Allowable Subject Matter

Claims 16 and 24 were objected to as being dependent upon a rejected base claim but were indicated as allowable if rewritten in independent form including all of the limitations of the base claim and any intervening claims. Claims 16 and 24 have been rewritten as new claims 26 and 29, each having 2 dependent claims. Allowance of these claims is respectfully requested.

Conclusion

Applicants submit that the claims as amended and the new claims all define patentably over the prior art and that this application is now in condition for allowance. Accordingly, favorable reconsideration and allowance of this application is courteously requested.

Respectfully submitted,



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